Life Sciences Division

Space Life Sciences

Flight Experiments Information Package

1999

A Companion Document
to
Agency Solicitations
in
Space Life Sciences

Issued by the International Space Life Sciences Working Group

Space Life Sciences
Flight Experiments and Ground Facilities
Information Package
1999

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Introduction

This supplement is a companion to 1999 research solicitations released by agency members of the International Space Life Sciences Working Group: United States (National Aeronautics and Space Administration, NASA), the European Space Agency (ESA), and the space agencies of Canada (Canadian Space Agency, CSA), France (Centre National d'Ètudes Spatiales, CNES), Germany (Deutsches Zentrum für Luft-und Raumfahrt, DLR), and Japan (National Space Development Agency of Japan, NASDA). The various sections of this supplement provide a common basis for proposal preparation and submission by any eligible scientist, regardless of the country of origin.

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Proposers submitting responses to agency solicitations should be aware that the proposal submission deadline for 1999 is **December 1, 1999**.

1.0 Space Life Sciences Proposal Evaluation Process

This section describes the evaluation and selection process that will be used for flight experiment proposals submitted to any member agency of the International Space Life Sciences Working Group (ISLSWG) in reply to the coordinated 1999 Life Sciences research announcements.

Each research proposal must be a complete response to the appropriate individual space agency's official solicitation. In that solicitation, an agency may define a number of critical constraints that proposals must satisfy to be considered for selection. For example, an agency may not accept proposals for work in certain discipline areas. Proposals to these agencies to carry out work which is not responsive to their solicitation will be returned without further review. For this reason, proposers are advised to communicate with their agency officials prior to submission if there is any doubt of the acceptability of a proposal by the agency in question.

Compliant proposals submitted in response to the Life Sciences Research Announcements will undergo an intrinsic scientific or technical merit review. Proposals that receive a passing score in this review will then undergo additional review(s) as follows:

- Flight feasibility review (flight experiments only)
- Relevance to the programs of the soliciting agencies
- Cost (applicable to proposals submitted to NASA, NASDA, and CSA only)

Proposals will undergo a three-tiered review process to assess these factors.

1.1 Scientific or Technical Merit Review

The first review will be a merit review by a panel of international scientific or technical experts. The number and diversity of experts required will be determined by the response to this research announcement and by the variety of disciplines represented in the proposals. The merit review panel will assign **a score from 0-100** or a score of "not recommended for further consideration" based upon the intrinsic scientific or technical merit of the proposal. This score will reflect the consensus of the panel.

The score assigned by this panel **will neither be affected by the cost of the proposed work nor reflect the programmatic relevance of the proposed work to the agencies**.

The following will be used to determine the merit score:

- **Significance:** Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field?
- **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics?

- **Innovation:** Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
- **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
- **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

1.2 Flight Feasibility Review

A second review will be an evaluation of the feasibility of implementing the proposed work using available facilities on a space platform. The Flight Feasibility Review will be conducted for each flight experiment proposal that receives a scientific merit score of 65 or above. An international team of engineers and scientists experienced in the development of space flight experiments will conduct this review. This team of experts will not necessarily have expertise in your area of science. Be sure to clearly and succinctly explain all of your experiment requirements and procedures in terms that an intelligent non-scientist can understand.

In addition to the actual proposal, the information requested in Form C (Section 5 of this document) is essential to the Flight Feasibility Review. Flight experiment proposals submitted without the information requested in Form C will not be evaluated.

It is important to note that during this early utilization phase of the ISS, resource constraints on the shuttle and ISS will favor selection of proposals with simple requirements and procedures. Of particular concern regarding the evaluation of the feasibility of a proposal is the identification of risk factors that could impact the implementation of an otherwise meritorious proposal. Therefore, the feasibility of implementing the proposal and associated risks will be evaluated using the following technical criteria:

- **Functional Requirements:** Will the planned flight and ground hardware meet the requirements of the experiment? What experiment-unique hardware will be required, and can it be developed in time for projected flight opportunities? Are the number of subjects or specimens required attainable within a reasonable period of time (1-2 years) considering projected flight opportunities, and other competition for those flight opportunities?
- **Operational Feasibility:** How complex are the experiment procedures? Will the crew have sufficient time to be trained to perform the experiment? Will they have sufficient time in space to perform the experiment? Are the requirements for launch vehicle loading and unloading of the experiment specimens compatible with the capabilities of these vehicles? Can requirements for data collection on human subjects be accommodated in the pre-flight and post-flight schedules for the astronauts? Has the experiment protocol taken into account the unavoidable delay between the launch of an

experiment and the actual initiation of the experiment? Will the experiment requirements for crew time, experiment volume, mass, power, or other features of on-orbit operations affect the completion of this or other experiments? What other impacts will the experiment have on activities or experiments planned for the same mission?

- **Environmental Health and Safety:** Are there elements of the proposed ground or flight activities that pose concerns for the health and safety of personnel and/or the environment? For experiments that utilize the crew as research subjects, could the implementation of these experiments, even if considered safe, lead to an impact on the performance of the human subjects with respect to their other crew duties? Is it possible that specific restrictions on the human subjects (such as diet, exercise, etc.) will interfere with other activities of these subjects?

Using the risk factors identified in the evaluation, a score will be assigned to indicate this level of uncertainty.

The Risk Assessment Score categories are:

Low Risk: minimal risk to the successful achievement of objectives
Medium Risk: moderate risk to the successful achievement of objectives
High Risk: extreme risk to the successful achievement of objectives

The proposers will not be provided the risk assessment score, but in cases where the decision to not select a proposal is based in part on the technical evaluation, a description of the identified risk factors will be provided to the proposer.

1.3 Evaluation of Programmatic Relevance and Cost

A third review will evaluate the programmatic relevance and cost of proposals which meet scientific/technical merit and flight feasibility criteria. This review will be conducted independently by program scientists and managers from each soliciting agency for proposals submitted to their specific solicitations. The contribution of the proposed work to the balance of scientific and technical issues identified by agencies in their research announcements is the determinant of programmatic relevance. Review of cost is applicable to proposals submitted to NASA, NASDA, and CSA only. Evaluation of cost will also be performed for proposals submitted to other agencies that include a component requiring NASA, NASDA, or CSA funding. Evaluation of the cost of a proposed effort will include consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds.

1.4 Recommendation for Selection for Further Definition

The results of these three levels of review will be used to prepare a recommendation for selection for further definition developed by each of the soliciting agencies. This recommendation will be based on:

1. The numerical score for merit from the peer review panel
2. The results of the flight feasibility review
3. The programmatic relevance
4. Cost (applicable as described in Section 1.3)

A high merit score does not guarantee selection. A proposal must also be feasible to implement, have programmatic relevance, and have reasonable projected costs if it is to be selected. The members of the ISLSWG will meet to ensure appropriate coordination of all their selections to optimize science return and resource utilization. For example, the composite selection will not greatly exceed the projected flight opportunities. In addition, it may be more efficient or effective to form international teams of researchers requiring similar resources to address overlapping questions than to have individuals competing for the use of the same specimens or test subjects. Experience has clearly shown that such teams are best formed at the time of selection and early in the experiment definition phase, rather than later during the flight experiment development process.

Following this coordination meeting of the ISLSWG, each agency will finalize and announce its own selections.

Applicants should be aware that selection for flight is a multi-step process. Following the complete review of flight proposals, successful investigators will receive a letter informing them that their experiment has been selected for entry into a Definition Phase. During the definition phase, the agency with management responsibility for the experiment will interact with the investigator to determine specific hardware and operational requirements needed to achieve the proposed objectives. Identification of issues that will affect implementation of the space flight experiment and refinement of the funding requirements are key components of the definition phase. After successful completion of this phase, the experiment will be selected for flight and enter into a development phase, leading eventually to implementation on a space mission. Detailed budgets will be refined or negotiated for each flight experiment during each phase. The flight experiments selected will be reviewed every year and may be de-selected based on the policy of each agency for de-selection.

2.0 Anticipated Flight Opportunities for Space Life Sciences

Flight experiment opportunities are limited and constrained in a number of ways. Proposals that require resources beyond the capabilities described in this section should <u>NOT</u> be submitted.

Given the limited availability of flight opportunities, flight experiments will be the most competitive area within space life sciences for selection in Fiscal Year 2000. Flight experiment proposals must represent mature studies strongly anchored in previous or current ground-based or flight research. Ground-based research may, and usually must, represent one component of a flight experiment proposal. For a flight experiment proposal, ground-based research should be limited to activities that are essential for the final development of an experiment for flight, such as definition of flight procedures and control activities for the flight experiment. In this case, only one (flight) proposal need be submitted.

Flight experiment proposals must clearly define the actual experiment duration, all requirements, and all conditions required to successfully complete the experiment. The investigator should allow for flexibility in the selection of the best hardware to be used to accomplish the experiment goals. Descriptions of the functional capabilities of hardware available to support human and non-human experiments are included in Section 3 of this document. Section 4 lists websites that contain more information about the hardware.

Some investigators may wish to develop their own special experiment hardware to work in conjunction with the facilities and functional capabilities of existing hardware. Development of experiment-unique equipment will require additional funding, and individual agencies may factor such cost negatively into their overall assessment. Design, construction, and flight of major experiment-unique equipment hardware items or facilities usually require the commitment of large quantities of resources (power, crew time, volume). In the event that such items are proposed, they should be clearly identified. Proposals for major hardware items or facilities to be developed by the investigator will not be considered.

Flight experiments should only be proposed if they can realistically be implemented in a timeframe compatible with their assignment of a flight opportunity between 2003 and mid-2004. With the Definition and Development Phases generally requiring approximately three years, experiments that cannot be conducted within this time period should not be submitted.

It is expected that the majority of experiments selected from proposals in response to this announcement will be performed on the International Space Station (ISS). A small number of flight opportunities may become available for experiments that do not require ISS resources and can be accommodated on the Space Shuttle. Because this prospect is uncertain, proposals for research appropriate for ISS will have the highest priority for selection and funding. Pre- and post-mission studies that involve tests of the astronaut crew prior to and upon return from their space flight may also be submitted.

Multiple flight opportunities may be provided when required. However, proposals that request only one flight to meet their proposed research goals will have a higher probability of accomplishment. Careful consideration and discussion of subject requirements in the proposal is highly recommended.

2.1 Flight Experiments

There are, in principle, two kinds of flight experiments possible: 1) experiments in the Space Shuttle with a typical flight duration of 8 to 11 days, and 2) experiments on the ISS with a potential flight duration of 90-120 days for human subjects and up to 90 days for non-human subjects.

2.1.1 ISS Flight Experiments

Research opportunities will be available on a limited basis during the construction phase of the ISS. The research will be accomplished during Space Shuttle missions when the Shuttle visits the ISS, and during the time period between the Space Shuttle missions when the ISS crew will act as experiment operators and, if necessary, as subjects. The duration of microgravity exposure during the 2003 to mid-2004 time period can, in theory, be indefinite with periodic disturbances of up to 5 days every 30 days caused by U.S. and Russian transportation vehicle docking activities.

During the period of time covered by this solicitation, space life sciences research is restricted to utilize a limited hardware set. The functional capabilities of this hardware set are described in Section 3 of this document. Section 4 lists the websites that contain more information about the hardware.

It is expected that power and logistics resupply to ISS (frequency of transport, power during transport, and mass of transported items) will be severely constrained throughout 2003 to mid-2004. The primary opportunities to transport scientific equipment, supplies, and samples will be on the periodic flights of the Shuttle which are specifically dedicated to this purpose. However, modest capabilities for research-related deliveries and sample returns may be available on shuttle flights dedicated to assembly of the ISS that will occur every 40 to 90 days. Refrigerated transport of samples on the Shuttle will be very limited, and during certain time frames, refrigerated storage may not be available on the Space Station. Power outages may also be experienced during the assembly of ISS. Experiments with few and/or simple crew-supported in-flight activities have the greatest potential for selection during this time frame due to limitations on crew time and crew training. Samples or specimens from experiments may be returned to Earth only periodically. Depending upon the duration of the experiment, storage of samples up to 90 days must be possible, even if an experiment lasts only a day or less. There is a minimum storage period of several days before starting an ISS experiment, since the Shuttle has to travel to and dock on the ISS and the experiment has to be transferred to its ISS facility. The requirements necessary to preserve the integrity of your experiment during these storage periods must be described on Form C.

The availability of the crew for science operations and as subjects of research will also be extremely constrained during 2003 and up to mid-2004. On average, a total of 2 to 5 hours of crew time per week will be allocated to life sciences experiments. Fifteen crew members will reside on the ISS during this year-and-a-half period. There is no assurance that all crew members will agree to participate as subjects in experiments.

2.1.2 Short Duration Flight Experiments

Short duration experiments may be accommodated on the Shuttle for approximately 11 days of microgravity exposure. The experiments themselves must be stand-alone studies that require only limited crew training and involvement to execute. It is possible to arrange for late pre-flight installation and early post-flight recovery of data and hardware in these circumstances. However, experiment hardware that occupies or requires a large volume to operate will not likely be accommodated.

Equipment and supplies that do not have a shelf-life limit may be loaded onto the shuttle days or weeks before launch. It is possible to arrange for late pre-flight installation (~Launch minus 20 hours) and early post-flight recovery (Landing plus 3 hours) of equipment, supplies, and data which have time- or temperature-critical sensitivities. Note that there are periods of time pre-flight and after landing when no access to the experiment is possible and maintenance of the experiment/data integrity must be assured. The requirements necessary to preserve the integrity of your experiment during these storage periods must be described on Form C.

As many as 75 shuttle crew members will support flights during this time period. The number of crew subjects available to perform short duration human studies will be restricted due to the limited amount of crew time available for such experiments, and there is no assurance that all crew members will agree to participate as subjects in experiments. The availability of Shuttle resources for experiments that require animal subjects will also be extremely limited for short duration experiments (see Sections 3 and 4). Experiments that do not require Shuttle power will be more easily accommodated.

2.2 Pre- and Post-Mission Studies

Opportunities will be available to perform experiments, collect samples, and take physiological measurements of the astronaut crew both prior to their space mission and following their return to Earth. Such proposals are considered flight experiments and should specify the desired activities, the time frame in which these activities must be performed prior to and following the mission, and the required mission duration (e.g., prior to and following a short duration Shuttle mission versus a longer duration ISS mission). As stated previously, fifteen crew members will reside on ISS from 2003 to mid-2004, while seventy-five subjects are potentially available for pre-and post-flight biomedical research for short duration missions. Access to long duration ISS crews for pre- and post-mission studies will be extremely limited. There is no assurance that all crew members will agree to participate as subjects in experiments. Access to the crew immediately before and upon return is extremely limited (availability of astronauts for research tests on the day of return to Earth, or the day after this, may be as little as 1 hour per day total).

2.3 Requirements Difficult to Implement During the Assembly Phase of ISS

There are certain experiment procedures that, while not impossible to perform, are difficult to implement during the assembly of the ISS. This section describes those requirements that may increase the risk level of an experiment. Requirements that may be difficult to accommodate include:

1. The need for a large allocation of in-flight crew time (procedure will take more than 3 hours per week).
2. Measurements to be made on <u>long-duration</u> crew members within their first days on-orbit, which implies that the measurements have to be made on the Shuttle before docking with ISS, or on the return trip.
3. Intensive Early Flight Activities (Flight Day 0 to Flight Day 15). Operations that require more than 1 hour per subject per day for more than 2 days during this period are considered intensive operations.
4. Baseline Crew Data Collection on the two days after landing (R+0 to R+2).
5. Baseline Crew Data Collection during the 30 days prior to Launch (L-30 to Launch).
6. Excessive Crew Training (more than 10 hours are required to familiarize a novice with the procedure).
7. A large number of crew subjects (more than 6).
8. Complex or invasive in-flight procedures on the crew, such as indwelling catheters, multiple hardware items that must be integrated or synchronized, precise requirements for when an experiment must be performed, complex skills required (e.g., in-flight biopsies, microneurography, etc.).
9. Large Upmass/Volume: Volume on the Space Shuttle is usually measured in "Middeck Locker Equivalents." A Middeck Locker can hold a volume with dimensions of 17.337in. x 9.969in. x 20.320in. and can hold a total of 60 lbs. A request of more than 3 of these dedicated to a single experiment on a single mission would be difficult to satisfy.
10. Procedures on non-human specimens on the day of launch (unless automated).
11. Procedures that require crew time prior to docking on ISS or on the day of landing.
12. Complex in-flight procedures on non-human specimens, such as surgeries or dissections.
13. Experiments that require more than one flight to meet objectives.

3.0 Flight Research Capabilities

3.1 Research Involving Human Subjects

Informed consent of human subjects must be obtained prior to carrying out any study in space, and potential applicants should be aware that obtaining such informed consent will involve a uniform process regardless of the country of origin of the applicants.

3.1.1 Physiological Monitoring

The ISS Human Research Facility (HRF) and the Space Shuttle are outfitted with the medical equipment necessary to make a variety of physiological measurements. Most of these measurements may be made in conjunction with exercise equipment or in combination with each other. The capabilities available for on-orbit research are summarized below. A table with the instruments available for flight experiments is listed at the end of this section.

- **Blood Pressure:** Capabilities will include noninvasive monitoring and collection of blood pressure data, both extended duration and intermittent, on human subjects. The data can be collected by manual or automated methods during periods of rest or exercise.

- **Electrical Stimulation of Muscle:** Local noninvasive muscle stimulation on human subjects will be possible using a high current stimulator which provides trains of pulses up to 0.8 amps, according to pre-programmed protocols.

- **ECG / EMG / EEG:** Acquisition of human physiological data such as ECG, EMG, EEG, temperature, and skin Galvanic responses will be possible. Multichannel data (16 differential channels) can be collected by means of portable, crew-worn devices over extended periods of time (24 hours), or via rack-mounted devices.

- **Pulse / Blood Oxygen:** A pulse oximeter will be available to monitor the percentage of hemoglobin oxygen saturation in the blood.

- **Lung Volume**: Respiration of crew members can be studied by continuously monitoring lung volume using respiratory impedance plethysmography.

- **Metabolic Activity / Pulmonary Physiology:** Two gas analysers will be available, one based on the use of mass spectrometry and the other on infra-red gas analysis techniques. Combined with ancillary equipment, including gas supplies for supplying special respiratory gas mixtures, the following measurements will be possible:

    - Breath-by-breath measurements of VO_2, VCO_2, VE
    - Diffusing capacity of the lung for CO.
    - Expiratory Reserve Volume
    - Forced Expired Spirometry
    - Functional Residual Capacity
    - Respiratory exchange ratio VO_2/VCO_2
    - Residual Volume
    - Total Lung Capacity
    - Tidal Volume
    - Alveolar Ventilation
    - Vital Capacity
    - Volume of pulmonary capillary blood
    - Dead-space ventilation
    - Cardiac output
    - Fractional inspiratory and expiratory volumes, F_{IO2} and F_{EO2}, F_{ICO2} and F_{ECO2}
    - Numerous other specialised tests of pulmonary function

- **Ultrasound / Doppler**: An ultrasound system is available to perform medical imaging and to measure flow rates. The system uses hand-held probes and performs functions to support cardiac ultrasound, abdominal ultrasound (deep organ), vascular ultrasound, muscle and tendon ultrasound, and transcranial ultrasound.

- **Venous Occlusion Cuff and Controller (VOCC):** An inflatable venous occlusion cuff system for the subject's thigh or arm allows for the control of parameters such as time between inflations and inflation pressure.

3.1.2 Sample Collection and Storage

Blood, urine, and saliva samples may be collected from crew subjects before, during, and after flight. Blood, urine, and saliva collection kits will be available for the collection, preservation, and storage of samples. Tracer kits will be available to provide oral ingestion, bolus-injection over a short period of time, or infusion over a designated period of time.

3.1.3 Exercise

There are two exercise devices available for research: a bicycle ergometer and a treadmill. The **Bicycle Ergometer** provides work load, driven by the hands or feet, that is controlled by manual adjustment or computer control. It operates with the subject seated or supine, and provides time-synchronized data compatible with other complementary analyses. The data output consists of work rates in watts and pedal speed (rpm) for use with a data acquisition system.

The **Treadmill** may be used for walking and running exercise. The device employs various strategies to simulate as closely as possible 1g skeletal loading during exercise bouts. The treadmill will measure and display the loads exerted on the subject by restraint harnesses prior to, during, and after the exercise bout. The Restraint System provides stabilization of the user, and load distribution on the body in a weightless environment. The treadmill can be motor-driven or operated passively. As with the bicycle ergometer, the treadmill provides data compatible with other complementary analyses.

3.1.4 Measurement of Muscle Strength, Torque and Joint Angle

The following capabilities related to measurement of strength will be available:

- Measurement of the torque, position and velocity generated during tests on the agonist and antagonist muscle groups of the trunk and extremity joints including ankle, knee, hip, wrist, elbow, shoulder, trunk, whole leg, and whole arm
- Measurement of these parameters during submaximal and maximal exercises, throughout the entire range of motion (except for shoulder) in the Isometric, Isokinetic (concentric and eccentric), and Isotonic (concentric and eccentric) modes:
- Simulation of ideal elements: spring, friction and inertia.
- Parameter control following predefined pattern: position control, velocity control, torque/force control, power control.
- Quick release of free motion.
- Complex combinations of the previous modes
- Bilateral torque and angular position/velocity measurements and training on the flexion and extension of the knee, ankle, trunk, hip, shoulder, elbow and wrist; supination/ pronation; radial/ulnar deviation.

- Bilateral force and linear position/velocity measurements and training on the following multi-joint linear movements:
  - Arm press (front, overhead and intermediate trajectories)
  - Leg press (front, down and intermediate trajectories)
- The displays available to the subject are highly programmable, i.e. display of peak torque vs. joint angles, and average torque at specific joint angles as well as torque-velocity throughout the entire range of motion, etc.
- The motion profiles are also highly programmable, (i.e. programming of variable and quantifiable velocities and resistances during training exercises), and the experiment profiles (i.e. assessment of fatigue over serial contractions)
- Measurement of hand grip strength or pinch strength as a function of time are available

3.1.5 Cardiovascular Loading

A lower body negative pressure (LBNP) device that encloses the lower abdomen and lower extremities to maintain a controlled pressure differential below ambient during periods of extended weightlessness will be available. This device may be used in conjunction with the physiological monitoring capabilities described above. It will provide pressure applications to the lower body in a range from ambient to -60 mm Hg. It allows performance of a continuous decompression to -60 mm Hg, at the range from 10 seconds to 10 minutes (i.e., rapid decompression to slow decompression).

An adjustable foot support, removable saddle, and knee fixation within the device provides skeletal “loaded” and “unloaded” LBNP. The decompression device is available not only for cardiovascular research, but also for any other physiological research.

3.1.6 Posture

Single axis loads between the foot and the supporting surface can be measured during any activity in which a crew member engages. In addition to the measurement of total force between the foot and the surface, regional force values may also be measured. Selective regional measurements of the loads applied to the rear-foot, mid-foot, medial metatarsal head, lateral metatarsal heads, hallux, and lesser toes can also be made.

3.1.7 Activity Monitoring

Measurements that are indicative of the crew’s activity level can be made using a small wrist- or ankle-worn device that can detect movement and light levels. The device is used to evaluate sleep/wake adaptation, circadian cycles, sleep quality, sleep onset, hyperactivity, and other daily routines of human activity. The device can be battery operated for up to 150 hours. Sampling rates of accelerations, light, and temperature are programmable.

3.1.8 Medical Procedures

It will be possible to deliver subcutaneous injections or infuse fluids intravenously. Approved substances may be ingested orally.

3.1.9 Eye Movements

A 3-dimensional Eye Tracking Device (ETD) for the recording of eye movements will be available. This device may be used to measure horizontal, vertical and/or torsional eye positions by means of digital processing of the recorded eye image sequences. Furthermore, head movements will be measured by means of three orthogonally arranged angular rate sensors and three orthogonally arranged linear accelerometers. This encompasses all three degrees of freedom of eye movement (in the head) and all six degrees of freedom of head movement in space.

3.1.10 European Physiology Modules

The European Physiology Module (EPM) is a multi-user facility supporting human studies. The initial instrument complement to be accommodated includes:

- Multi-Electrode EEG Mapping Module (MEEMM). The main features of the MEEMM are:

  - Supporting up to 128 EEG channels, using gel-free electrodes
  - Acquisition of 128 EEG channels at 600 Hz sampling with 22 bit resolution
  - Acquisition of 32 EEG channels at 100,000 Hz sampling with 24 bit resolution
  - Additionally supporting up to 32 channels of EMG acquisition
  - Additionally supporting acquisition of 16 EEG channels at 600 Hz sampling during ambulatory or sleep studies

- Bone Analysis Module (BAM). Evaluation of the mineralisation state of the Calcaneous using ultrasound. The BAM determines:
  - Speed Of Sound (SOS), with a reproducability between measurement sessions of 0.2%.
  - Broad-band Ultrasonic Attenuation (BUA), with a reproducability between measurement sessions of 1.6%.

  The BAM produces an ultrasonic image of the Calcaneous thereby avoiding errors associated to the repositioning uncertainity one measurement session to the next.

- Body Movement Analysis Instrument (ELITE-S2). ELITE-S2 is an instrument for the quantitative analysis of human kinematics in weightlessness. It uses video techniques, operating in the infra-red (IR). IR-reflecting markers are mounted on the subjects trunk and limbs. The markers are illuminated with IR flashes from flash guns mounted close to the video cameras. Up to eight cameras can be used to determine 3-D position of the markers and to help eliminate ambiguities with respect to the marker positions.

- CARDIOLAB. CARDIOLAB is a group of instruments. The actual flight complement is not yet finalized, but is likely to include:
    - a Portapres continuous blood pressure registration device
    - an ECG Holter
    - arm-cuff blood pressure Holter
    - 2 lead and 15 lead ECG devices
    - portable ultrasound doppler instrument
    - tonometer pencil
    - air limb plethysmograph
    - absolute limb volume device
    - body impedance tomography device
    - near infrared photoplethysmograph
    - eye fundascope
    - ISTAT
    - hemoglobinometer
    - cold pressor glove
    - calf ergometer
    - leg/arm occlusion cuff system
    - hematocrit centrifuge

- Physiological Pressure Measurement Instrument (PPMI): Battery operated unit for the measurement of central venous pressure and other physiological pressures, such as esophageal pressure.

- Xenon Skin Blood Flow Measurement Instrument (XSMI): Battery operated unit for determining skin blood flow by the determination of the dilution of a subcutaneous injection of a bolus of a radioactive tracer (Xe-133).

Hardware Available to Support Human Subject Research	**Shuttle-Based**	**ISS-based**	**Agency**
Physiological Monitoring			
Manual Blood Pressure Device	X		NASA
Automatic Blood Pressure System	X		NASA
Continuous Blood Pressure Device		X	NASA
Combined Blood Pressure Monitoring		X	NASA
Percutaneous Electrical Muscle Stimulator	X	X	NASA/ESA
Pulmonary Function System		X	NASA/ESA
Gas Analyzer Mass Spectrometer		X	NASA
Hardware Available to Support Human Subject Research (cont.)	**Shuttle-Based**	**ISS-based**	**Agency**
ECG / EMG / EEG	X	X	NASA
Holter Monitor	X	X	NASA
Pulse Oximeter	X	X	NASA
Respiratory Impedance Plethysmograph	X	X	NASA
Ultrasound Doppler		X	NASA

Venous Occlusion Cuff and Controller	X		NASA
Sample Collection and Stowage			
Human Sample Collection Kits	X	X	NASA
Exercise			
Bicycle Ergometer	X	X	NASA
Treadmill	X	X	NASA
Muscle Strength, Torque, and Joint Angle			
Muscle Atrophy Research and Exercise System		X	NASA/ESA
Resistive Exercise Device		X	NASA
Hand Grip/Pinch Force Dynamometer	X	X	NASA/ESA
Cardiovascular Loading			
Lower Body Negative Pressure	X	X	DLR
Activity Monitoring			
Activity Monitor		X	NASA
Medical Procedures			
Injection and Infusion System	X	X	NASA
Eye Movements			
3 D Eye Tracking Device	X	X	DLR
European Physiology Modules			
Multi Electrode EEG Mapping Module		X	ESA
Bone Analysis Module		X	ESA
Body Movement Analysis Instrument		X	ESA
CARDIOLAB		X	ESA
Physiological Pressure Measurement Instrument		X	ESA
Xenon Skin Blood Flow Measurement Instrument		X	ESA

3.2 Research on Cells

It is possible to fly live cell cultures of various types for up to 90 days on orbit. Types of cultures that can be used include suspended and attached plant and animal cell cultures, animal tissue, bacterial cultures, and small, non-feeding aquatic organisms. Fresh cell cultures may be prepared from frozen cells transported to the ISS. Cell cultures of 3, 10, or 30 ml volume can be maintained within a temperature range of 4 to 40°C, and an atmosphere with controlled humidity, temperature, pH, carbon dioxide, and oxygen levels. Cell images can be observed and evaluated by a phase-contrast/fluorescence microscope. Images may be transmitted to the ground laboratories when required. The experiment may be designed with simultaneous onboard reference samples under an artificial gravity (0.001 to 2.0g) environment. Nutrients or special additives can be introduced into the culture media automatically, and waste products can be removed automatically to maintain a specific growing environment. In addition, fixatives may be introduced to terminate a study and prepare specimens for further analysis on the ground. Alternatively, specimens or the culture matrix may be sampled on orbit directly for further manipulation or storage. Simple cell manipulation essential for the experiment, such as solution mixing, DNA/RNA extraction, trypsinization, filtration, and concentration, may be carried out by a semi-automated method or by assistance of the crew. Videomicroscopy of either 40 or 200x, spectrophometry, and a phase-contrast/fluorescence microscope will be provided. The culture chamber environment is sterile, and cells may be placed on the spacecraft just prior to launch.

Hardware to support research on cells	**Shuttle-Based**	**ISS-based**	**Agency**
Cell Culture Module – no centrifuge capacity	X	X	NASA
DLR SIMPLEX	X	X	DLR
Biopack	X		ESA
Cell Culture Unit		X	NASA
Cell Biology Experiment Facility		X	NASDA
Modular Cultivation System		X	ESA
Incubator		X	NASA
Biolab		X	ESA

3.3 Research Using Insects

Insects and larvae can be maintained in a variety of hardware to suit the needs of the researcher. On-orbit, the temperature will be maintained between 15°C and 40°C, the relative humidity controlled between 20-90% and illumination between 0-50µW/cm^2. Air exchange, CO_2/O_2, vibration and radiation can be monitored. Video recording or downlink is available. Specimens may be chemically fixed or frozen for analysis on the ground. Centrifugation of specimens is possible with most of the hardware listed below. In some cases, specimens can be transported at a temperature between 4°C and 40°C, with a relative humidity controlled between 20-80% and illumination between 0-20µW/cm^2.

Hardware available for Research on Insects	**Shuttle-Based**	**ISS-based**	**Agency**
Biological Research in Canisters (BRIC)- passive system	X	X	NASA
Biopack	X		ESA
Modular Cultivation System		X	ESA
Insect Habitat		X	CSA/NASA
Cell Biology Experiment Facility		X	NASDA
Hardware available for Research on Insects (cont.)	**Shuttle-Based**	**ISS-based**	**Agency**
Incubator		X	NASA
Biolab		X	ESA

3.4 Research Using Plants

During the time period for which these solicitations apply, plant research is limited to experiments with small specimens (e.g., Arabidopsis). The seeds or plants may be planted, grown, harvested, fixed, and stowed on orbit. The methods for performing those operations may be tailored to the needs of the investigator. Centrifugation (carousel diameter up to 600 mm) with accelerations from 0.001 to 2.0g, temperature control, controlled air composition, ethylene removal, water resupply, illumination, observation, and data acquisition are available in a variety of flight-certified hardware.

Hardware available for Research on Plants	**Shuttle-Based**	**ISS-based**	**Agency**
Biolab		X	ESA
Biological Research in Canisters (BRIC)	X	X	NASA
Biomass Production Facility	X	X	NASA
Biopack	X		ESA
Cell Culture Unit (plant cell culture only)		X	NASA
Cell Biology Experiment Facility		X	NASDA
Plant Experiment Unit – attaches to CBEF		X	NASDA
Modular Cultivation System		X	ESA
Incubator		X	NASA
Plant Growth Facility	X		NASA

3.5 Research Using Aquatic Specimens

Diverse aquatic plants, invertebrates, and early life-stages of fish and amphibians can be accommodated in various habitats for short durations on the shuttle or longer durations on ISS. Centrifuge facilities are available with some aquatic habitats allowing accelerations between 0.001 and 2g and among the habitats, temperature ranges from +10°C to +40°C are available. Habitats have various capabilities for observation, atmosphere control, illumination, water resupply, specimen fixation, and data collection.

In addition, CEBAS, a fresh water equilibrated biological aquatic system that allows controlled incubation of fish, invertebrates, and plant specimens (*Xiphophorus helleri, Biomphalaria glabrata, Ceratophyllum spec*.) is available for short duration experiments. The experiment module offers different compartments for adult and larval stages of fish, snails, plant material, and the microbiological filter system with a total volume of approximately 8.5l. The support module controls water flow, thermal conditions, and illumination cycles (including O_2 dependent plant illumination), as well as monitoring and storage of water parameters (temperature, pH, pO_2) and video recording. Water quality is maintained and regulated within the equilibrated biological aquatic system where every organism serves as an experimental object as well as an integral part of the life support system.

Hardware available for Research on Aquatic Specimens	**Shuttle-Based**	**ISS-based**	**Agency**
Aquatic Research Facility	X		CSA
CEBAS	X		DLR
Biopack	X		ESA
Cell Culture Unit (non-feeding only)		X	NASA
Modular Cultivation System		X	ESA

Biolab		X	ESA

3.6 Research Using Quail Eggs

3.6.1 Avian Development Facility Validation Flight

In late 2000, a test will be conducted onboard ISS to validate the performance of the Avian Development Facility (ADF). A biospecimen sharing plan will be used to distribute available tissue to investigators. Fertile quail eggs from *Coturnix coturnix japonica* (n=36) will be placed on the 2 carousels in the ADF, chilled at 13°C to arrest development, and launched. Once on orbit the eggs will be warmed to 38°C and maintained at this temperature for the duration of the incubation. When the incubator reaches 38°C, one carousel containing 18 eggs, will begin rotation to provide a 1g centrifuged control while the other carousel remains stationary to expose the eggs to microgravity In addition, all eggs will be turned 180 degrees in two opposing directions about the longitudinal axis daily. Humidity will be regulated between 50% and 75%. Oxygen concentration will be maintained above 21% and CO_2 below 0.3%. Individual eggs will be fixed at various stages of development by immersion of the embryo in 25 ml of 4% formaldehyde. It should be noted that fixative penetration of the tissues at late developmental stages is limited and detailed histological evaluation of late stage embryos may not be feasible.

3.7 Research Using Rodents

For this year only, due to limited flight opportunities in the near future, flight experiments using rodents are not being solicited. Please refer to the individual Agency solicitations for more information.

3.8 Comparison of hardware available on ISS

Selected features of various ISS multipurpose biological research facilities. For more details, see the specific web pages of the respective facilities.

Abbreviations:
EC= Experiment Container; °C= degrees Celsius; g= unity of gravity; l= litre; LED= Light Emitting Diode; LSS= Life Support System; mm= millimeter; N/A= not applicable; rh= relative humidity; tbd= to be determined.

	Biopack (Biorack)	BIOLAB	Modular Cultivation System	Cell Culture Unit	Cell Biology Experiment Facility
Incubator temperature [°C]	20 - 37	18 - 40	18 - 40	4 - 39 (4 to 45 heat shock)	15 - 40
Humidity control	no	60%-90%	50%-90% (20%-90%)	N/A	30%-80%
EC volume [l]	0.065/ 0.345	0.36	0.58	0.002-0.03	0.18-1.66
EC height [mm]	20/62 (20)	60	160	2.38	60-71
Rotor diameter [mm]	150 (175)	600	600	(2500)	350
Radial acceleration [xg]	0.1-2.0 (0.1-1.0)	EC center: 0.001-2.0	outer radius: 0.001-2.0	0.01-2.0	0.1-2.0
Illumination	no	LED	LED (tbd)	LED	(inside EC)
Video observation	no	yes	yes	yes	(inside EC)
Water supply	no	no	yes	(media supply)	(inside EC)
LSS	no	yes	yes	yes	CO_2, rh

3.9 General Support Capabilities

3.9.1 Temperature-Controlled Storage

There are a number of hardware systems and methods for the maintenance of specific temperatures for specimens or preserved samples.

- Ambient Storage (approx. 20°C – 28°C)
- Refrigeration (+4°C)
- Freezing (-20°C to -80°C)

Experiment operational requirements, hardware availability, and sample volumes dictate which system or combination of systems are used to accommodate specific experiment objectives. In addition, a number of inserts and containers are available to manage the samples. There are also a large number of tools, surgical instruments, and kits designed for a wide range of applications in support of on-orbit biomedical and fundamental biology investigations.

Hardware available for Temperature Controlled	**Shuttle-Based**	**ISS-based**	**Agency**

Stowage			
Incubators	X	X	NASA
Passive Freezers	X		NASA
Minus Eighty Degree Life Sciences Freezer		X	NASA/ESA
GN_2 Freezers	X		NASA

3.9.2 Mass Measurement

The ISS will have the capability to measure the mass of the human body, live animal specimens, plants, solids, semi-solids, and liquids (in containers). The small mass measurement range will be from 1g to 5kg, and the micro mass range will be from 10 mg to 10 g.

Hardware available to Measure Mass	Shuttle-based	ISS-based	Agency
Small Mass Measurement Device		X	NASA
Body Mass Measurement Device		X	NASA
Micro Mass Measurement Device		X	NASA

3.9.3 Computers

A laptop computer outfitted with mass storage devices, communication adapters, power supplies and cables, and custom built software is available for use. It can operate software written for Microsoft Windows.

A computer workstation will be available that is capable of providing high capacity data collection and mass storage, display of high resolution graphics, video processing, and real-time data processing. The workstation will be compatible with a wide variety of operating systems including DOS/Windows, UNIX/X-windows, OS/2, Windows NT, and Mac OS. The workstation will also be capable of uploading and downloading software and data and be capable of multichannel equal interval sampling and precise reaction time measurement.

Computers available	Shuttle-based	ISS-based	Agency
Laptops	X	X	NASA
Human Research Facility Computer Workstation		X	NASA

3.9.4 Radiation Monitoring

A passive dosimeter system will be available on the ISS to determine the space radiation dose for payloads at specific locations within ISS. It uses thermoluminescent detectors (TLDs) to accumulate dose, and a reader/annealer to measure that dose on-orbit. TLD sensitivity varies depending on the energy spectrum of the space radiation present. Therefore, it is necessary to use plastic nuclear track detectors (PNTDs) to determine the energy spectrum of the radiation absorbed by the TLDs. The PNTDs are co-located with TLDs during dose accumulation. The PNTDs are returned to the ground and are processed and analyzed in a laboratory to obtain the linear energy transfer (LET) spectrum. The LET spectrum is then combined with the dose information from the TLDs to determine a corrected total dose. This system can provide dose information for periods as short as 10 minutes or as long as one year.

Three active dosimeter systems will be available on ISS: the Real-time Radiation Monitoring Device (RRMD), a tissue equivalent proportional counter (TEPC) and a charged particle directional spectrometer (CPDS). Incidences of charged particles detected by RRMD will be monitored on the ground in real-time. Small chambers for biological specimens and passive dosimeters may be attached to the RRMD sensor unit. The TEPC will be moved around the pressurized volume of ISS in the first few months of operation in order to map out the radiation environment. It will eventually be based in the Habitation Module of ISS, but will continue to be used for periodic surveys of the various modules, in order to capture the effects of adding more modules onto the vehicle as well as solar cycle modulation of the radiation environment. This instrument has the capability for real-time data collection and viewing.

The CPDS will also have limited real-time data collection capability. There are two CPDSs. One will be housed inside the Habitation Module (not available until late 2004) and the other, a triple CPDS with 3-axis sensitivity, will be located outside on the S0 truss. The intravehicular CPDS will also be moved from module to module to conduct surveys. Initially, the instruments' first priority will be to support operational measurements, including contingencies. Eventually, the data is expected to become available for payload users.

Radiation Monitoring Tools	Shuttle-based	ISS-based	Agency
Tissue Equivalent Proportional Counter	X	X	NASA
Charged Particle Directional Spectrometer	X	X	NASA
Passive Dosimeters	X	X	NASA
Realtime Radiation Monitoring Device	X	X	NASDA

3.9.5 Video Imaging

Activities may be documented using video and still cameras. Formats will probably be 35mm (positive and negative) and 8mm camcorder. Most habitats for non-human specimens provide both data and video downlink.

Various image data taken by video or digital cameras inside of experiment hardware will be accepted by the Image Processing Unit (IPU) through the ISS data network. IPU encodes or edits the image data. NTSC video image inputs are digitized into MPEG2. Still images are compressed to TIFF/LZW format. These processed image data are sent down to the ground via the ISS data traffic. The IPU also has capability to store images in digital videotapes or removable hard disks.

Video Imaging	Shuttle-based	ISS-based	Agency
Cameras	X	X	Various
Image Processing Unit		X	NASDA

3.9.6 Centrifuges

In addition to the centrifuges which are built into various habitats and facilities, specific centrifuges will be available for processing of biological samples such as blood and saliva.

Centrifuges	**Shuttle-based**	**ISS-based**	**Agency**
Hematocrit Centrifuge	X	X	NASA
HRF Refrigerated Centrifuge		X	NASA
Orbiter Centrifuge	X		NASA

3.9.7 Gloveboxes and Specimen Manipulation

Gloveboxes provide an enclosed environment to conduct manipulations of specimen, chambers, materials, and science support equipment necessary to conduct experiments in orbit. These gloveboxes have been designed to isolate the crew from potentially hazardous materials used during experiment operations such as fixations, injections, waste removal, and dissections while maintaining an internal environment suitable for specimen manipulation. Additionally, the Bio-Glovebox can be sterilized with ozone. There are also a large number of tools, surgical instruments, and kits designed for a wide range of applications in support of on-orbit biomedical and fundamental biology investigations.

Gloveboxes	**Shuttle-based**	**ISS-based**	**Agency**
Bio-Glovebox (part of Biolab)		X	ESA
Clean Bench		X	NASDA
Life Sciences Glove Box		X	NASA
Standard Interface Glovebox	X		NASA

3.9.8 Microscopes

ISS has advanced microscopy capabilities for specimen manipulation and observation. It will be equipped with a compound microscope that is capable of fluorescent, dark-field, bright field, phase contrast and differential interference microscopy at magnifications ranging from 200 to 1000X and dissecting microscope with ring or transmitted lighting at magnifications ranging from 4 to 120 X. Real-time imaging and data downlink is available.

4.0 Flight Hardware Websites

The following tables are the same as the ones embedded in the previous text, but they provide the websites where more information can be found about the specific hardware items.

Table 4.1 Hardware Available to Support Human Subject Research	**Websites**
Physiological Monitoring	
Manual Blood Pressure Device	http://lslife.jsc.nasa.gov/hardware/mbpd.html
Automatic Blood Pressure System	http://lslife.jsc.nasa.gov/hardware/abps.html
Continuous Blood Pressure Device	http://lslife.jsc.nasa.gov/hardware/cbpd.html
Combined Blood Pressure Monitoring	
Percutaneous Electrical Muscle Stimulator	http://www.estec.esa.nl/spaceflight/pems.htm
Pulmonary Function System	
Gas Analyzer Mass Spectrometer	http://lslife.jsc.nasa.gov/hardware/gasmap.html
ECG / EMG / EEG	
Holter monitor	http://lslife.jsc.nasa.gov/hardware/holter.html
Pulse Oximeter	http://lslife.jsc.nasa.gov/hardware/pulseox.html
Respiratory Impedance Plethysmograph	
Ultrasound Doppler	http://lslife.jsc.nasa.gov/hardware/ultra.html
Venous Occlusion Cuff and Controller	
Sample Collection and Stowage	
Human Sample Collection Kits	http://lslife.jsc.nasa.gov/hardware/sample.html
Exercise	
Bicycle Ergometer	http://lslife.jsc.nasa.gov/hardware/cevis.html
Treadmill	http://lslife.jsc.nasa.gov/hardware/tvis.html
Muscle Strength, Torque, and Joint Angle	
Muscle Atrophy Research and Exercise System	http://www.estec.esa.nl/spaceflight/mares.htm
Resistive Exercise Device	
Hand Grip/Pinch Force Dynamometer	http://www.estec.esa.nl/spaceflight/hd.htm
Cardiovascular Loading	
Lower Body Negative Pressure	http://lslife.jsc.nasa.gov/hardware/lbnp.html
Posture	
Foot-Ground Interface	http://lslife.jsc.nasa.gov/hardware/fgi.html
Activity Monitoring	
Activity Monitor	http://lslife.jsc.nasa.gov/hardware/actmonitor.html
Medical Procedures	
Injection and Infusion System	

Table 4.1 (cont.) Hardware Available to Support Human Subject Research	Websites
Eye Movements	
3 D Eye Tracking Device	
European Physiology Modules	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Multi Electrode EEG Mapping Module	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Bone Analysis Module	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Body Movement Analysis Instrument	http://www.estec.esa.nl/spaceflight/mfc/default.htm
CARDIOLAB	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Physiological Pressure Measurement Instrument	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Xenon Skin Blood Flow Measurement Instrument	http://www.estec.esa.nl/spaceflight/mfc/default.htm

Table 4.2 Hardware Available to Support Non-Human Subject Research	Websites
Research on Cells	
Cell Culture Module	http://www.spacebio.com/CCM.htm
DLR SIMPLEX	
Biopack	http://www.desc.med.vu.nl/Frames.htm
Cell Culture Unit	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Cell Biology Experiment Facility	http://srdb.tksc.nasda.go.jp/eng/index_e.html
Modular Cultivation System	http://www.estec.esa.nl/spaceflight/index.htm
Incubator	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Biolab	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Research on Insects	
Biological Research in Canisters (BRIC)	http://atlas.ksc.nasa.gov/flight/
Biopack	http://www.desc.med.vu.nl/Frames.htm
Modular Cultivation System	http://www.estec.esa.nl/spaceflight/index.htm
Insect Habitat	http://www.science.sp-agency.ca/H1-IH(eng).htm
Cell Biology Experiment Facility	http://srdb.tksc.nasda.go.jp/eng/index_e.html
Incubator	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Biolab	http://www.estec.esa.nl/spaceflight/mfc/default.htm

Table 4.2 (cont.) Hardware Available to Support Non-Human Subject Research	Websites
Research on Plants	
Biolab	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Biological Research in Canisters (BRIC)	http://atlas.ksc.nasa.gov/flight/
Biomass Production System	
Biopack	http://www.desc.med.vu.nl/Frames.htm
Cell Culture Unit (plant cell culture only)	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Cell Biology Experiment Facility	http://srdb.tksc.nasda.go.jp/eng/index_e.html
Plant Experiment Unit – attaches to CBEF	http://srdb.tksc.nasda.go.jp/eng/index_e.html
Modular Cultivation System	http://www.estec.esa.nl/spaceflight/index.htm
Incubator	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Plant Growth Facility	http://atlas.ksc.nasa.gov/flight/
Research on Aquatic Specimens	
Aquatic Research Facility	http://www.science.sp-agency.ca/H1-ARF(Eng).htm and http://atlas.ksc.nasa.gov/flight/
CEBAS	http://atlas.ksc.nasa.gov/flight/
Biopack	http://www.desc.med.vu.nl/Frames.htm
Cell Culture Unit (non-feeding only)	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Modular Cultivation System	http://www.estec.esa.nl/spaceflight/index.htm
Biolab	http://www.estec.esa.nl/spaceflight/mfc/default.htm
Research using Quail Eggs	
Avian Development Facility	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html

Table 4.3 General Purpose Research Support Hardware	Websites
Thermal Control	
Incubators	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Passive Freezers	
Minus Eighty Degree Life Sciences Freezer	
GN_2 Freezers	http://atlas.ksc.nasa.gov/flight/
Mass Measurement	
Small Mass Measurement Device	
Body Mass Measurement Device	
Micro Mass Measurement Device	

Table 4.3 (cont.) General Purpose Research Support Hardware	Websites
Computers	
Laptops	
Human Research Facility Portable Computer	http://lslife.jsc.nasa.gov/hardware/compport.html
Human Research Facility Computer Workstation	http://lslife.jsc.nasa.gov/hardware/compwork.html
Radiation Monitoring Tools	
Tissue Equivalent Proportional Counter	
Charged Particle Directional Spectrometer	
Passive Dosimeters	
Realtime Radiation Monitoring Device	http://srdb.tksc.nasda.go.jp/eng/index_e.html
Video Imaging	
Cameras	
Image Processing Unit	
Centrifuges	
HRF Centrifuge	http://lslife.jsc.nasa.gov/hardware/cent.html
HRF Refrigerated Centrifuge	http://lslife.jsc.nasa.gov/hardware/rc.html
Orbiter Centrifuge	
Gloveboxes	
Bio-Glovebox (part of Biolab)	http://www.estec.esa.int/spaceflight/biolab.htm
Life Sciences Glove Box	http://spaceprojects.arc.nasa.gov/Space_Projects/SSBRP/index.html
Clean Bench	http://srdb.tksc.nasda.go.jp/eng/index_e.html
Standard Interface Glovebox	
Microscopes	
Compound Microscope	
Dissecting Microscope	

5.0 International Application Forms and Instructions for Proposal Preparation

This section contains the general instructions for proposal preparation and the specific forms required by proposers responding to agency solicitations for flight experiments in the space life sciences for 1999. The forms at the end of this section include the following:

Form A Solicited Proposal Application

Form B Proposal Abstract

Form C	Space-Flight Experiment Information Summary
Form D	Biographical Sketch
Form E	Other Support
Form F	Detailed Budget, First Year (NASA and CSA PI or Co-I ONLY)
Form G	Detailed Budget, Entire Project Period (NASA and CSA PI or Co-I ONLY)
Form H	Checklist for Proposers

General Instructions for Proposal Preparation

The information contained in these instructions is specific to the research solicitations and repeats or supplements the general guidance provided in agency specific announcements.

All proposals should include one copy of each of the Forms A through D as part of the complete submission. In addition, proposals submitted to NASA and CSA should include Forms E, F, and G. Proposals submitted to an international solicitation which include co-investigators from the U.S. or Canada should include Forms E, F, and G completed with the budgetary requirements of these co-investigators.

The proposal must include the following material, in this order:

(1) Cover Page: Solicited Proposal Application (Form A)*
(2) Proposal Abstract (Form B)
(3) Proposal Title Page, with Notice on Restriction on Use and Disclosure of Proposal Information, if any
(4) Project Description
(5) Space Flight Experiment Information Summary (Form C)
(6) Management Approach
(7) Letter of Assurance of Foreign Support (if applicable)
(8) Biographical Sketch (Form D)
(9) Other Support (Form E)
(10) Facilities and Equipment
(11) Special Matters (specific information on animal or human subjects protocol approval required, if applicable)*
(12) Detailed Budget, 12 Month (Form F), if applicable
(13) Detailed Budget, Entire Project Period (Form G), if applicable
(14) Supporting Budgetary Information (if applicable)
(15) Checklist for Proposers (Form H)
(16) Appendices, if any (reviewers are not required to consider information presented in appendices)

(17) Computer diskette (3.5 inch, Macintosh or PC format) containing an electronic copy of the principal investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B. The diskette should be labeled with the investigator's name, proposal title, and word processing program used to develop the diskette (i.e., Microsoft Word 6.0 for Windows)

* One signed original required

The Project Description Section is limited to 20 pages. Any pages in this section beyond 20 will not be reviewed. There is no specific page limitation on other sections of submitted proposals. However, every effort should be made to keep proposals as brief as possible. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the Forms in this Document where special places are provided for this information. Note that the proposal <u>must</u> specify the period of performance for the work described; periods of performance may be for any duration up to three (3) years but should be suitable for the project proposed.

The following paragraphs provide instructions for filling out the forms.

5.1 Cover Page: Solicited Proposal Application (Form A)

All of the information requested on Form A must be provided, and one original signature version of this form should be submitted.

For Item (7) on this form, <u>new</u> means that a proposal for this project has not been submitted to the soliciting agency from 1996 to 1998, <u>renewal</u> means that this proposal is for the continuation of an already funded task beyond the term of the funded proposal, and <u>revised</u> means that this proposal represents a revision of a proposal submitted to the soliciting agency and reviewed from 1996 to 1998, but not selected. A proposal previously submitted but not selected should be termed revised even if the original principal investigator has changed for 1999. Renewal and revised applications should contain special material described in the Project Description section below.

Note that items (9) and (10) on Form A require assurance of compliance with human subject and/or animal care provisions of agency and governmental regulations. Applicants should refer to the agency solicitation for specific instructions in this area.

5.2 Proposal Abstract (Form B)

The information requested on this form is essential to the review of the proposal. It determines how the application will be evaluated and which agency manager(s) will receive the final review materials for possible inclusion in one of the research programs of the agency.

5.3 Proposal Title Page

The title page should contain the project title, name and address of the submitting institution, the name, address and telephone number of the principal investigator, and the names and institutions of any co-investigators. Proposers should refer to agency specific solicitations for instructions regarding additional information which should be included on the title page.

5.4 Project Description

The length of the Project Description section of the proposal should not exceed 20 pages using regular (12 point) type. Any page beyond 20 will not be reviewed. The proposal should contain sufficient detail to enable a reviewer to make informed judgements about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with the resources requested and with their own resources. The proposal should indicate clearly the relationship between the proposed work and the research emphases defined in the agency specific solicitations. The development of a clear hypothesis, along with the available data evidence should be emphasized in this section. In addition, the proposals should provide evidence of ground research completed or to be carried out to justify a flight experiment.

5.5 Space Flight Experiment Supplementary Application Information (Form C)

All applicants proposing space flight research <u>must</u> provide the information requested on Form C. The information on this form is essential for the technical evaluation of the feasibility of performing the proposed study. Before filling out this form, applicants should read Section 2 of this document carefully and make certain that they understand the constraints that are associated with flight experiments. Keep in mind that this form is used primarily by a team of experts that does not necessarily have expertise in your area of science. Be sure to clearly and succinctly explain all of your experiment requirements, trivial to grand, in terms that an intelligent non-scientist can understand.

5.6 Management Approach

Each proposal <u>must</u> specify a single principal investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant, and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

5.7 Letter of Assurance of Foreign Support

Please refer to the individual agency Life Sciences Research Announcements for more details.

5.8 Biographical Sketch (Form D)

The Principal Investigator is responsible for direct supervision of the work and must participate in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the Principal Investigator that includes his or her current position title and educational background, a list of principal publications, and a description of any exceptional qualifications must be included. Use Form D to describe the research and professional experience of each professional staff member. Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. Do not exceed two pages. Omit personal information which does not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

5.9 Other Support (Form E)

Use the format described in Form E to list other sources of research support for the proposed Principal Investigator and each of the proposed co-investigators. Please list all active support as well as any pending support.

5.10 Facilities and Equipment

Describe the available facilities and major items of equipment specially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Provide evidence that such facilities or equipment will be made available if the applicant is successful in obtaining funding. Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. The need for items that can be typically used for research and non-research purposes should be explained.

5.11 Special Matters

The Special Matters section must contain appropriate statements regarding human subject or animal care provisions. Proposers should refer to the agency specific solicitations for instructions on this section.

5.12 Detailed Budget, 12 Month (Form F) and
5.13 Detailed Budget,Entire Project Period (Form G)

Applicants whose organization is within the United States and Canada are required to submit the information requested on Forms F and G. In addition, applicants to the ESA or NASDA solicitations which include co-investigators from the U.S. or Canada should provide this information relative to the participation of these co-investigators. Foreign proposals from organizations outside the U.S. and Canada which do not have a U.S. or Canadian co-investigator should not submit these forms.

Principal investigators in Japan should complete form JP-3, provided in the NASDA announcement. This form should also be completed by co-investigators in Japanese institutions named in proposals to other agencies' research announcements.

5.14 Supporting Budgetary Information

Applicants responding to the NASA and CSA solicitations are required to submit this information. In addition, applicants to the ESA or NASDA solicitations which include co-investigators from the U.S. or Canada should provide this information relative to the participation of these co-investigators.

This section must include information which supports the costs submitted in Forms F and G. In this solicitation, the terms "cost" and "budget" are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: $1,000, or Labor: $6,000) may cause delays in evaluation and award. Generally, costs will be evaluated as to realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained in this section. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

<u>Direct Labor</u>
Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate such as currently paid rates or outstanding offers to prospective employees. This format allows the agency to assess cost reasonableness by various means including comparison to similar skills at other organizations.

<u>Other Direct Costs</u>
Please detail, explain, and substantiate other significant cost categories as described below:

- <u>Subcontracts</u>: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
- <u>Consultants</u>: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).

- Equipment: List separately. Explain the need for items costing more than $5,000 (or the equivalent in Canadian dollars). Describe the basis for the estimated cost. For proposals to NASA, General Purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
- Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
- Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on the destination and the number of travelers, where known.
- Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the agencies to understand the basis for the estimate.

5.15 Checklist for Proposers (Form H)

One copy of a completed version of this checklist should be attached to the transmittal letter.

5.16 Appendices, if any

Appendices may be included, but proposers should be aware that reviewers are not required to consider information presented in appendices.

5.17 Computer Diskette

A diskette (3.5 inch, Macintosh or PC format) should contain an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B. The diskette should be labeled with the investigator's name, proposal title, and word processing program used to develop the diskette (i.e., Microsoft Word 6.0 for Windows).

The Required Application Forms

must be downloaded separately from

http://peer1.idi.usra.edu/peer_review/nra/99_HEDS_02.html